

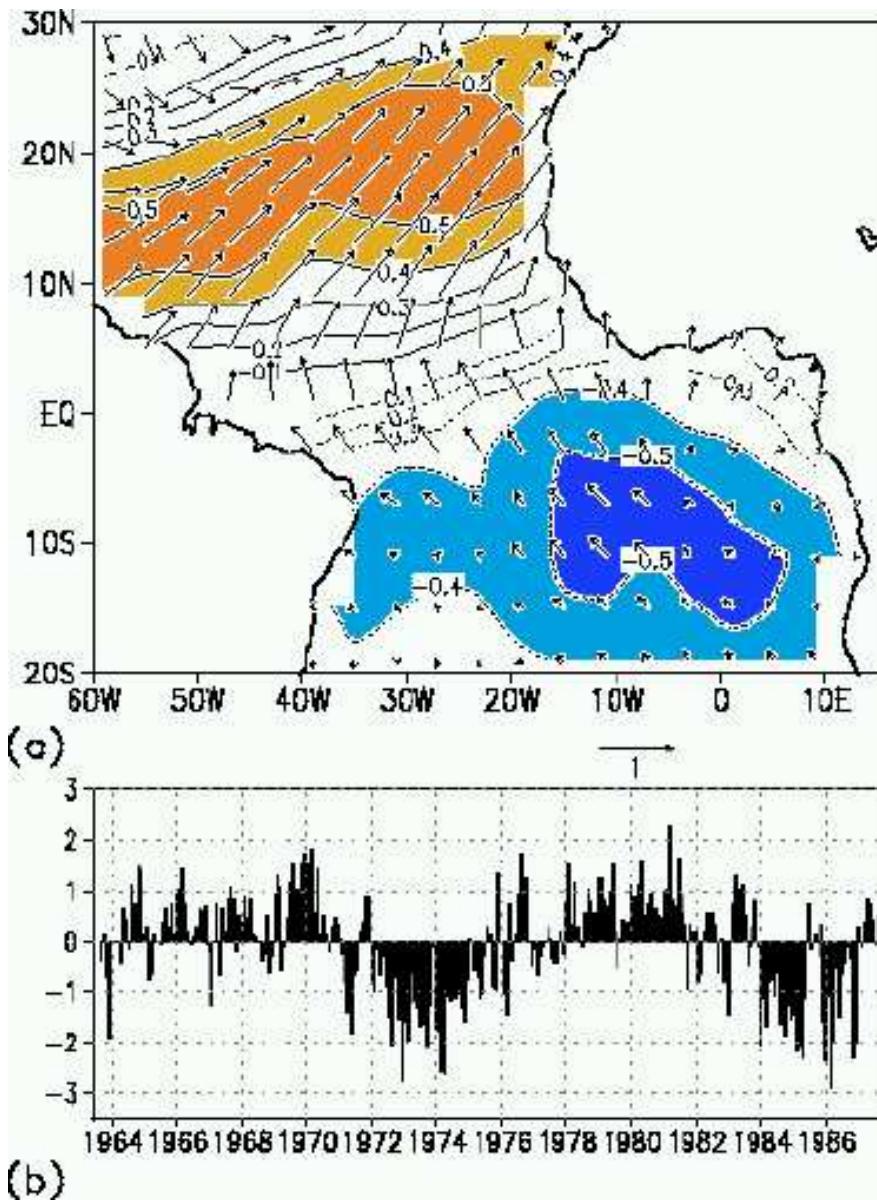
The role of oceanic heat advection in the evolution of off-equatorial tropical Atlantic SST anomalies

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Interhemispheric gradient mode



First EOF of SST, winds
(Nobre and Shukla 1996)

- Wind-induced latent heat flux drives SST (Carton et al. 1996, Seager et al. 2000, Chang et al. 2001)
- Oceanic heat advection damps SST anomalies (Seager et al. 2001)

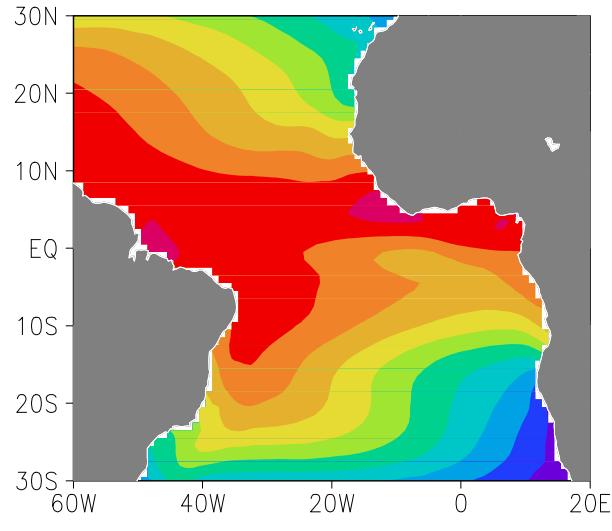
Data

- Satellite/reanalysis turbulent heat fluxes (Yu et al. 2004)
- Satellite-based radiative heat fluxes (Zhang et al. 2004)
- NCEP/DOE reanalysis-2 winds (Ekman currents)
- ERS-1/2/TOPEX/Poseidon/Jason sea level (geostrophic currents)

- Reynolds et al. (2002) SST
- Montégut et al. (2004) mixed layer depth, climatological
- $2^\circ \times 2^\circ$ horizontal resolution, monthly means (1983–2002)

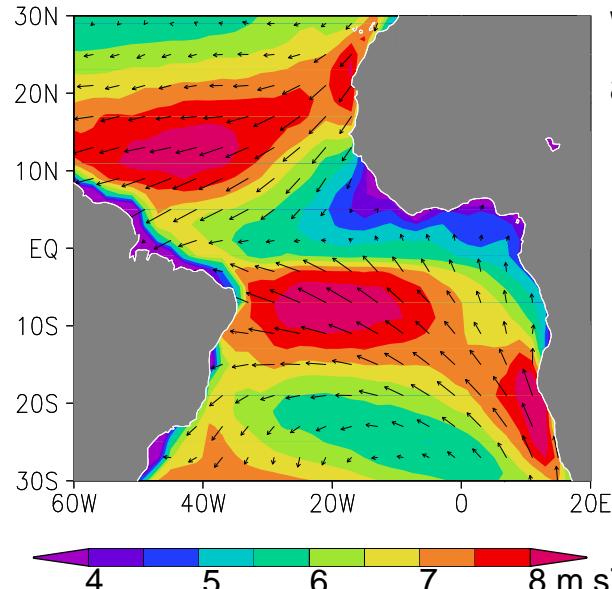
Annual mean surface fields

Sea surface
temperature



18 20 22 24 26 28 °C

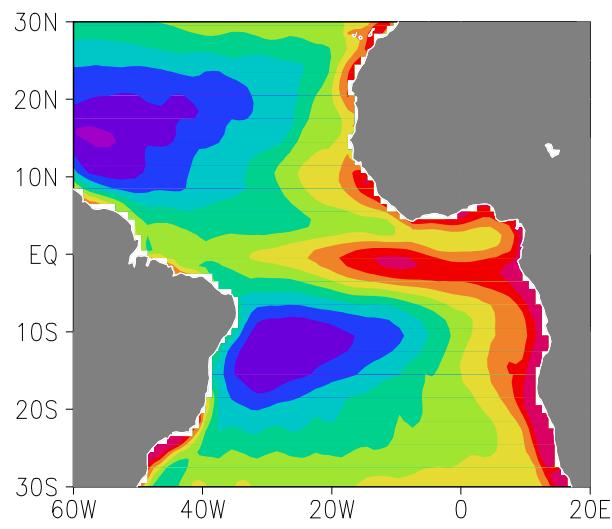
Wind speed
and stress



→
 0.2 N m^{-2}

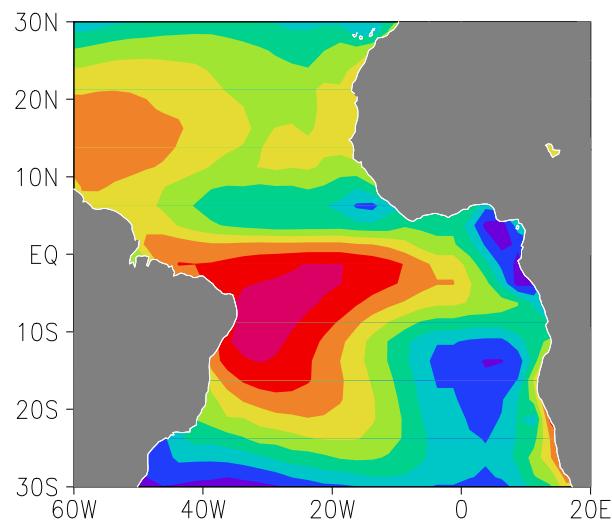
4 5 6 7 8 m s^{-1}

Latent heat
flux



-180 -160 -140 -120 -100 -80 W m^{-2}

Shortwave
radiation



200 220 240 260 W m^{-2}

Mixed layer heat equation

Storage

Advection

Surface heat flux

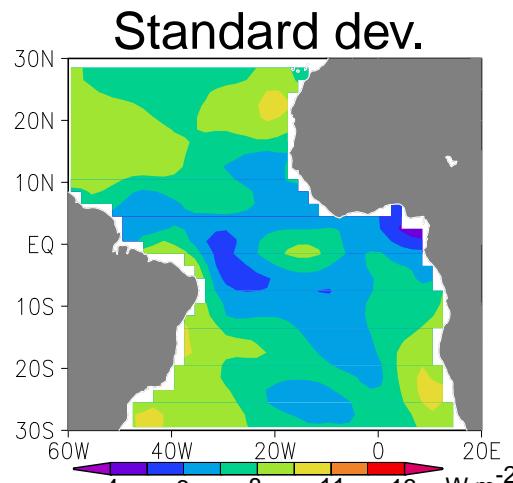
$$h \frac{\partial T}{\partial t} = -h \mathbf{v} \cdot \nabla T - H \Delta T w_e - \nabla \cdot \int_{-h}^0 \hat{\mathbf{v}} \hat{T} dz + \frac{q_0 - q_{-h}}{\rho c_p}$$

$$f h \hat{k} \times \mathbf{v} = -gh \nabla \eta + \frac{\tau}{\rho} - r \mathbf{v}_e$$

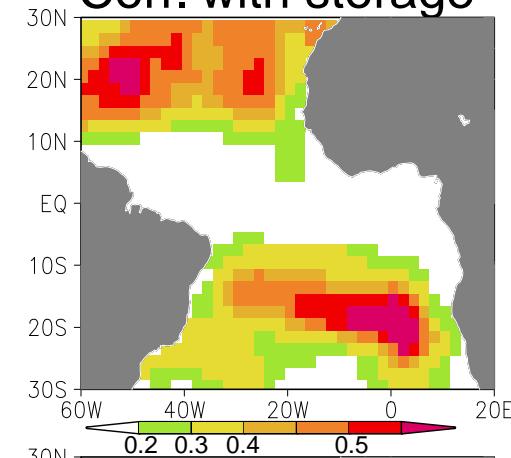
Surface heat flux anomalies

Latent heat
flux

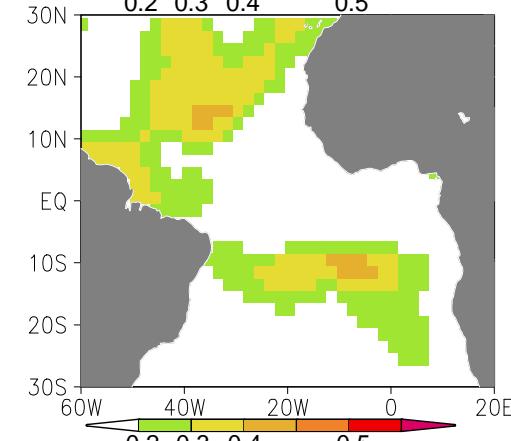
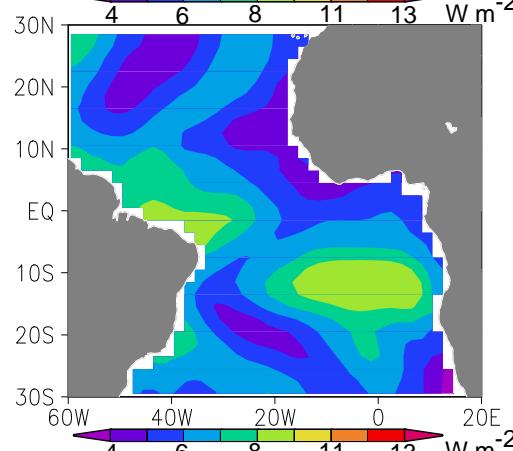
1983 - 2002



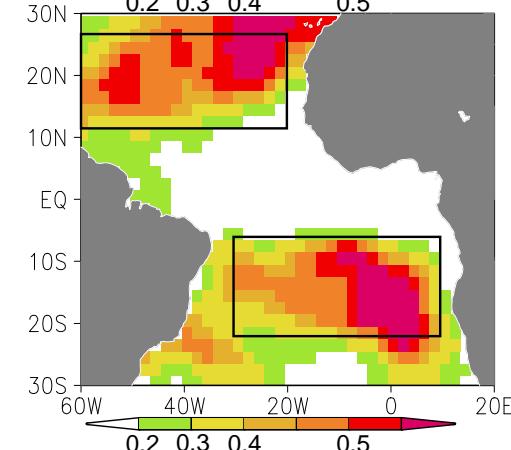
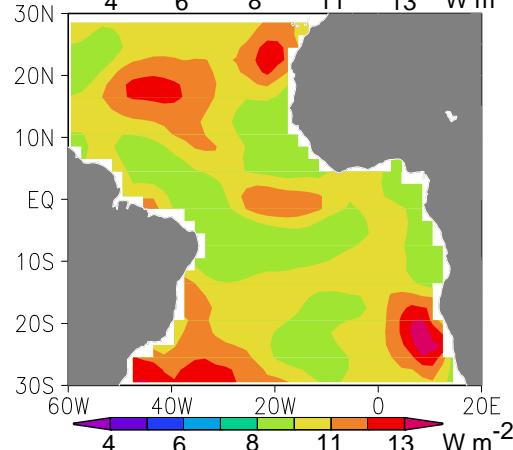
Corr. with storage



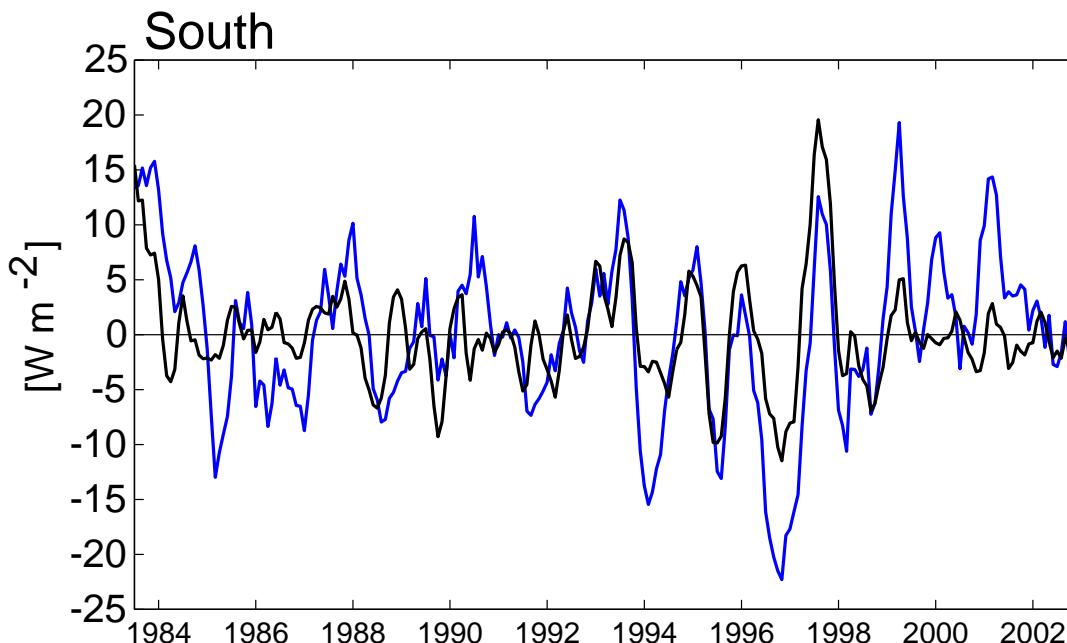
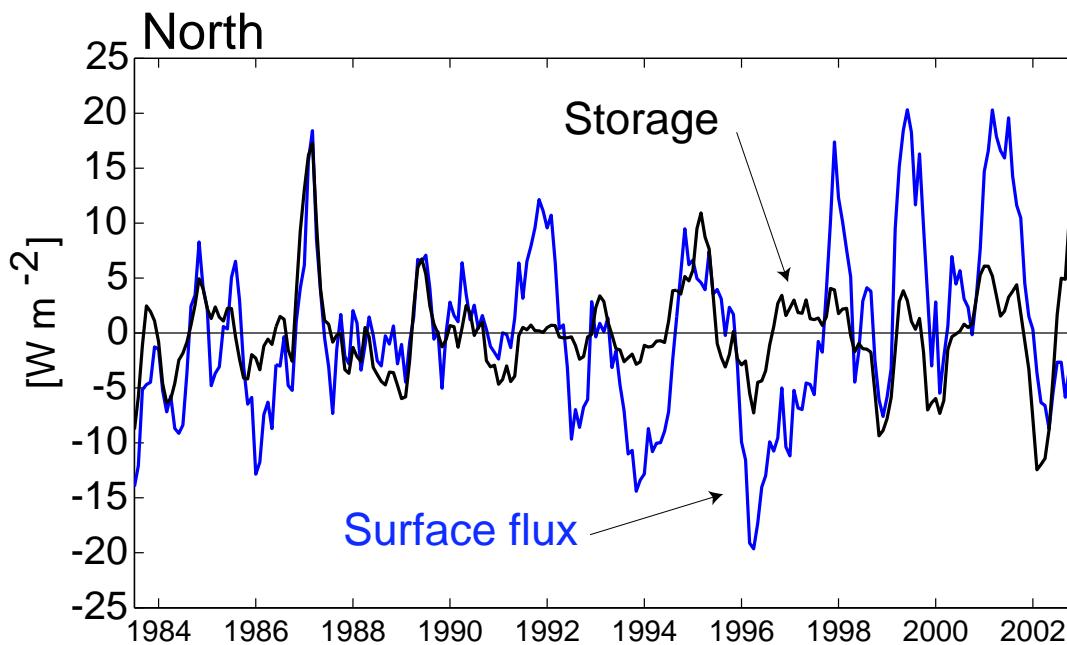
Shortwave
radiation



Net surface
flux

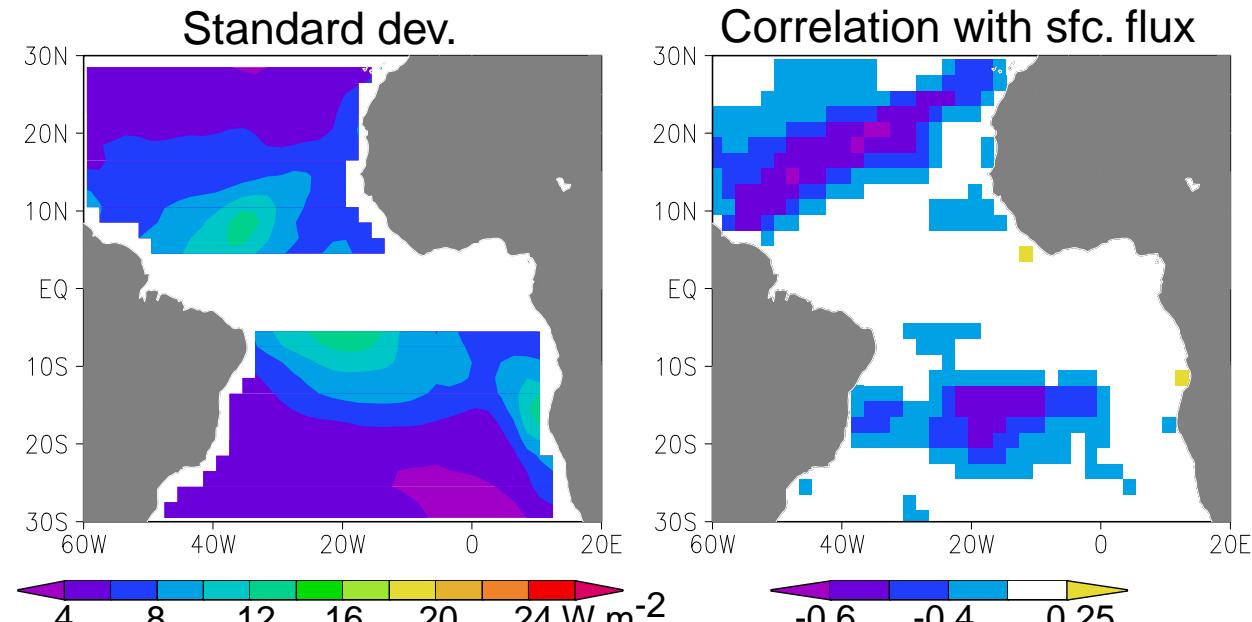


Surface flux, storage anomalies

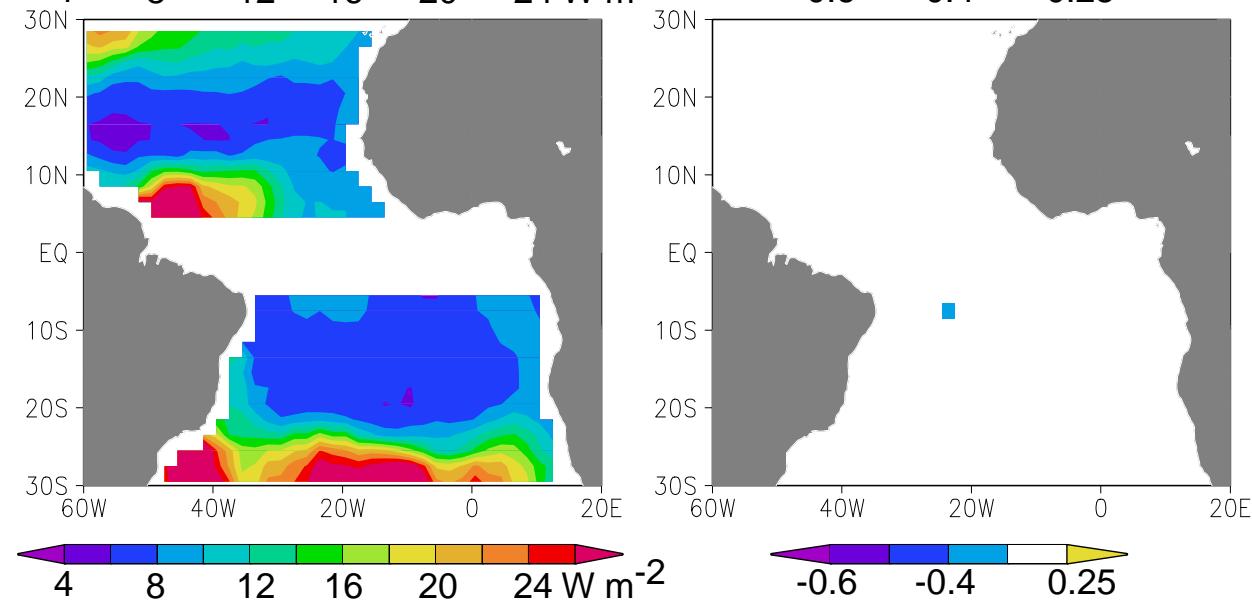


Ekman and geostrophic advection

Ekman
1992 - 2002

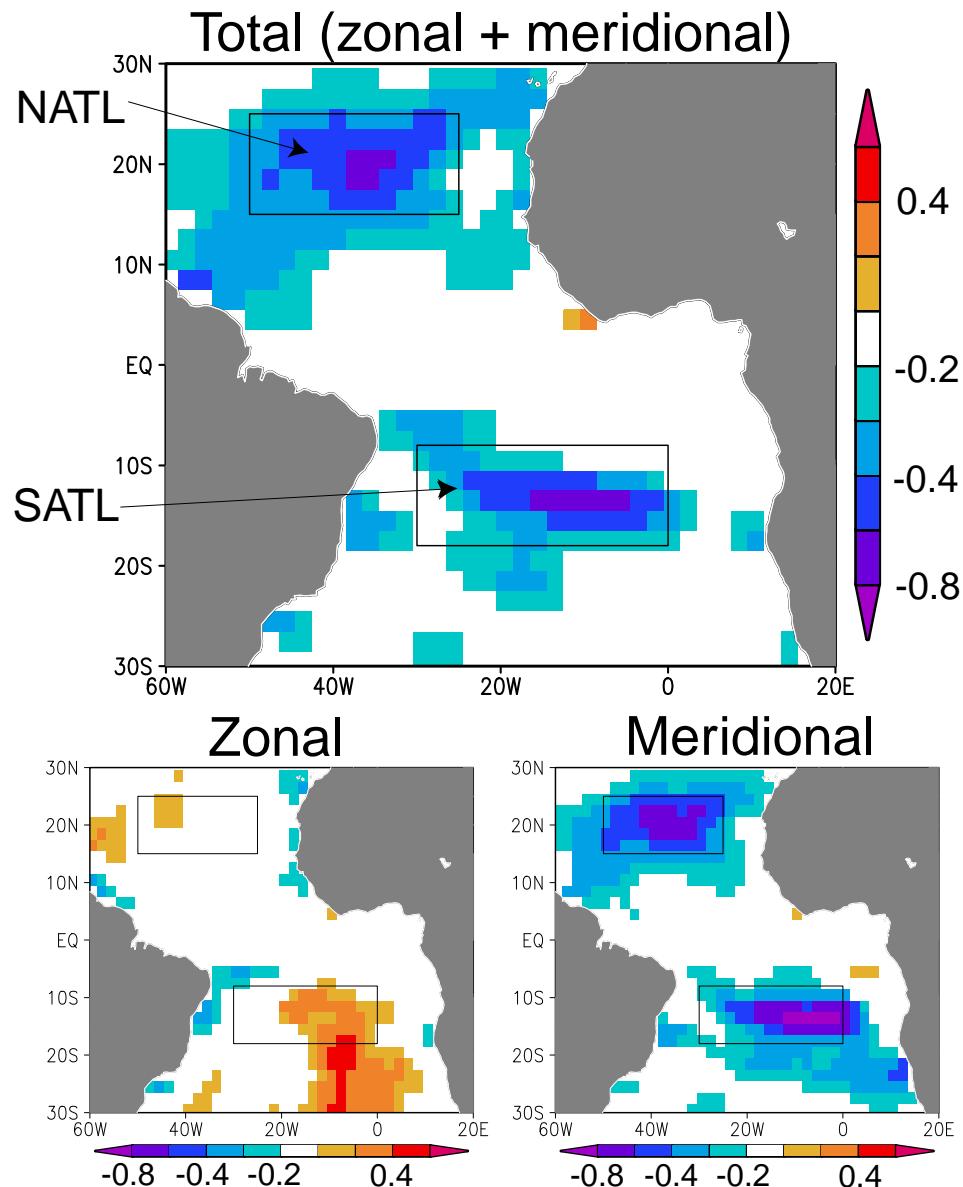


Geostrophic
1992 - 2002



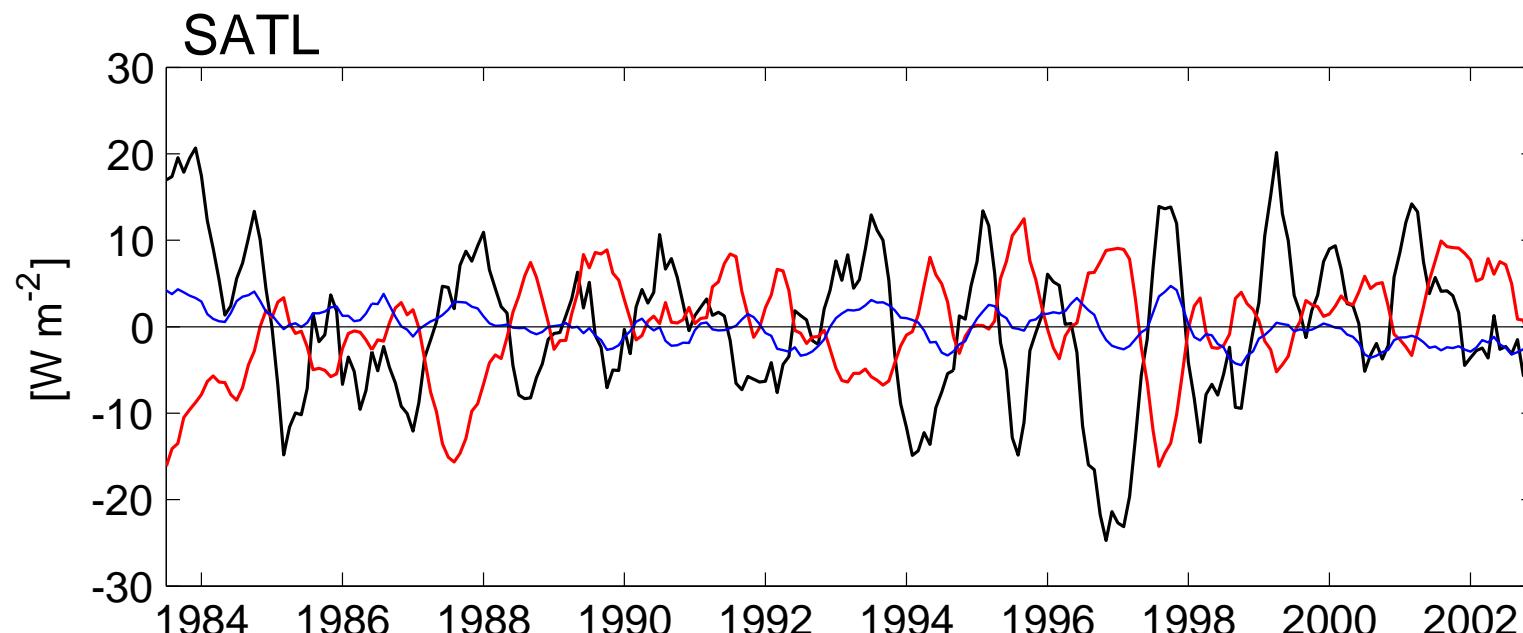
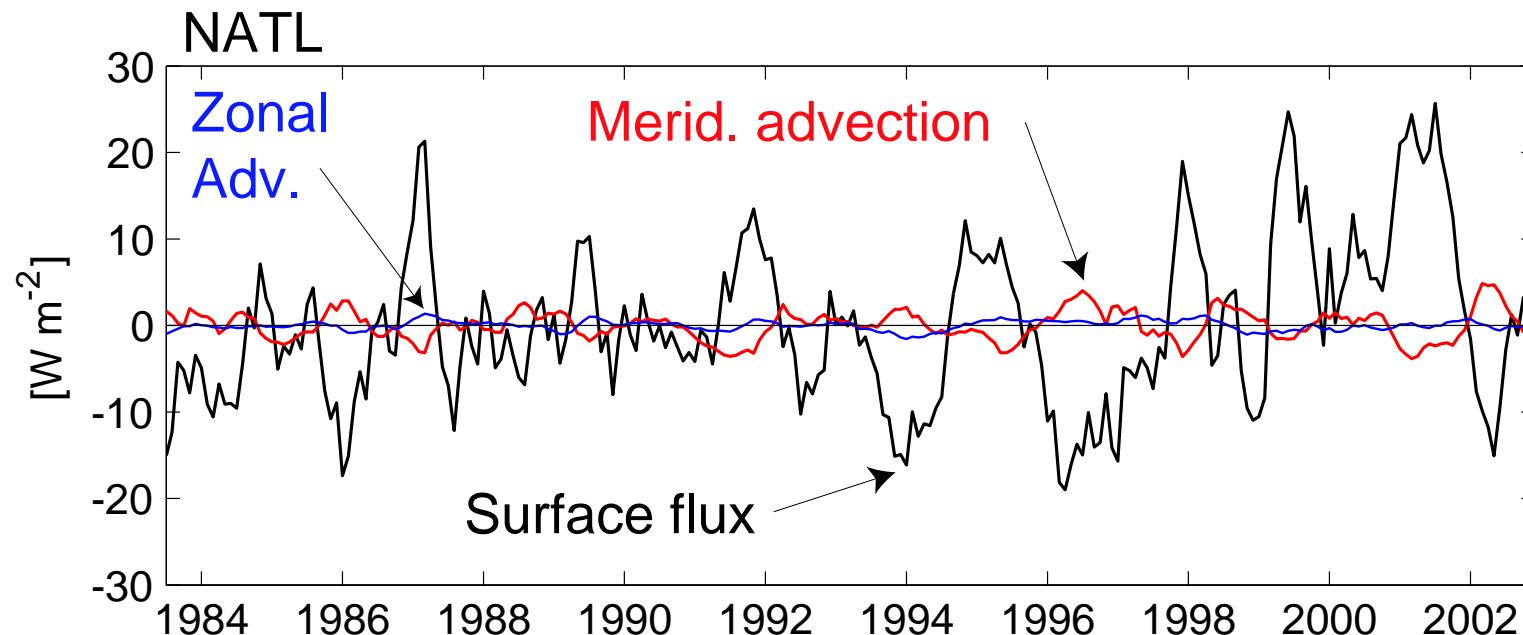
Ekman advection anomalies

Correlation with sfc. flux, 1983 - 2002



- Significant negative correlations (advection damps flux-driven SST anomalies)
- $v' \bar{T}_y$ and $\bar{v} T_y'$ contribute equally in both regions

Surface flux, advection anomalies



Summary

- Latent heat flux dominates net surface heat flux in off-equatorial tropical Atlantic
- Horizontal advection damps flux-driven SST, strongest 10°S – 20°S
- Results are similar to Xie (1999) and Seager et al. (2001), except we find strongest damping farther poleward, with maximum in tropical South Atlantic

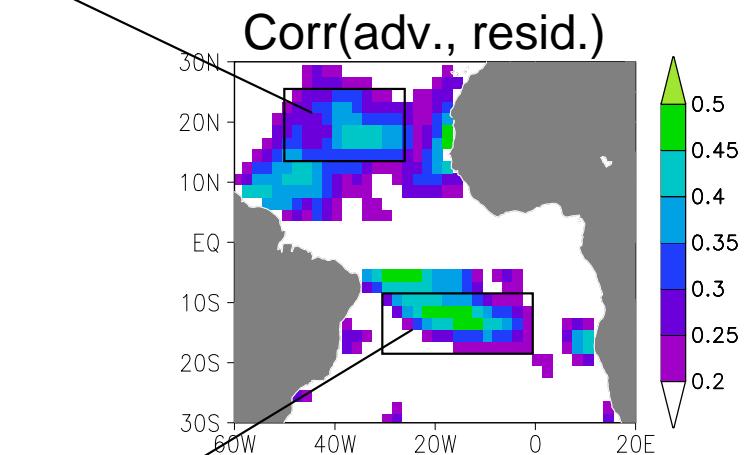
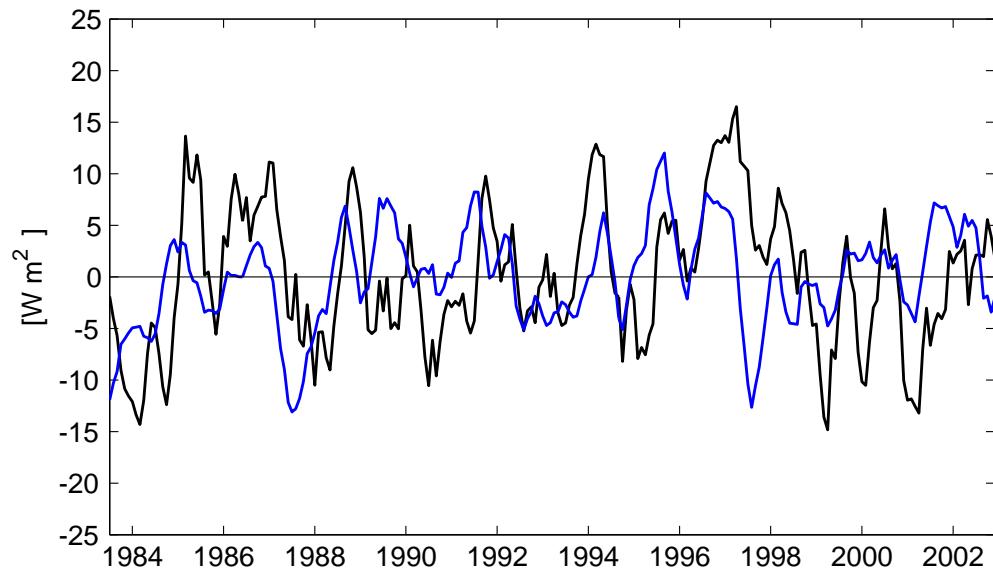
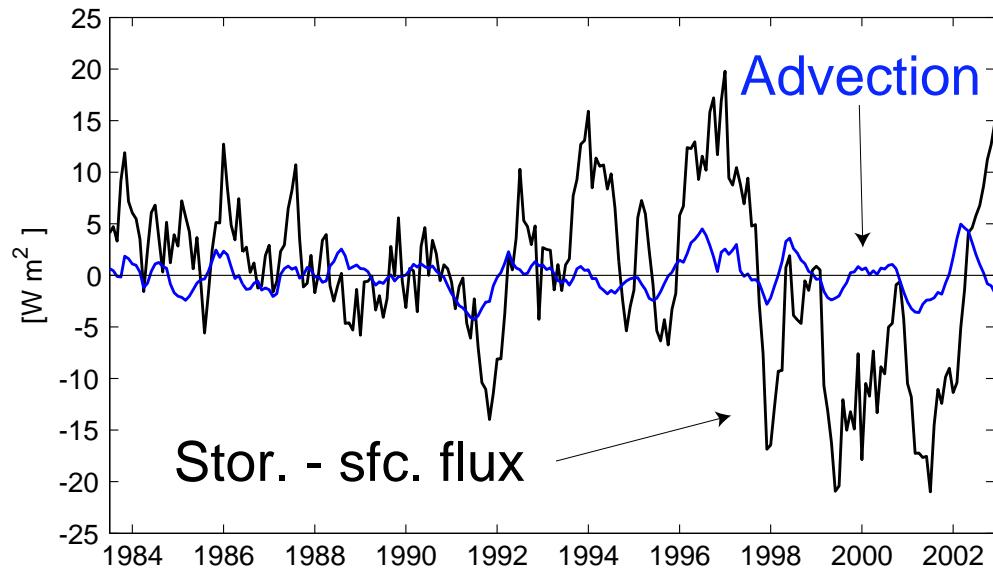
Balanced heat budget?

$$h \frac{\partial T}{\partial t} - \frac{q_0}{\rho c_p} \stackrel{?}{=} (-h \mathbf{v} \cdot \nabla T)_{Ekman}$$

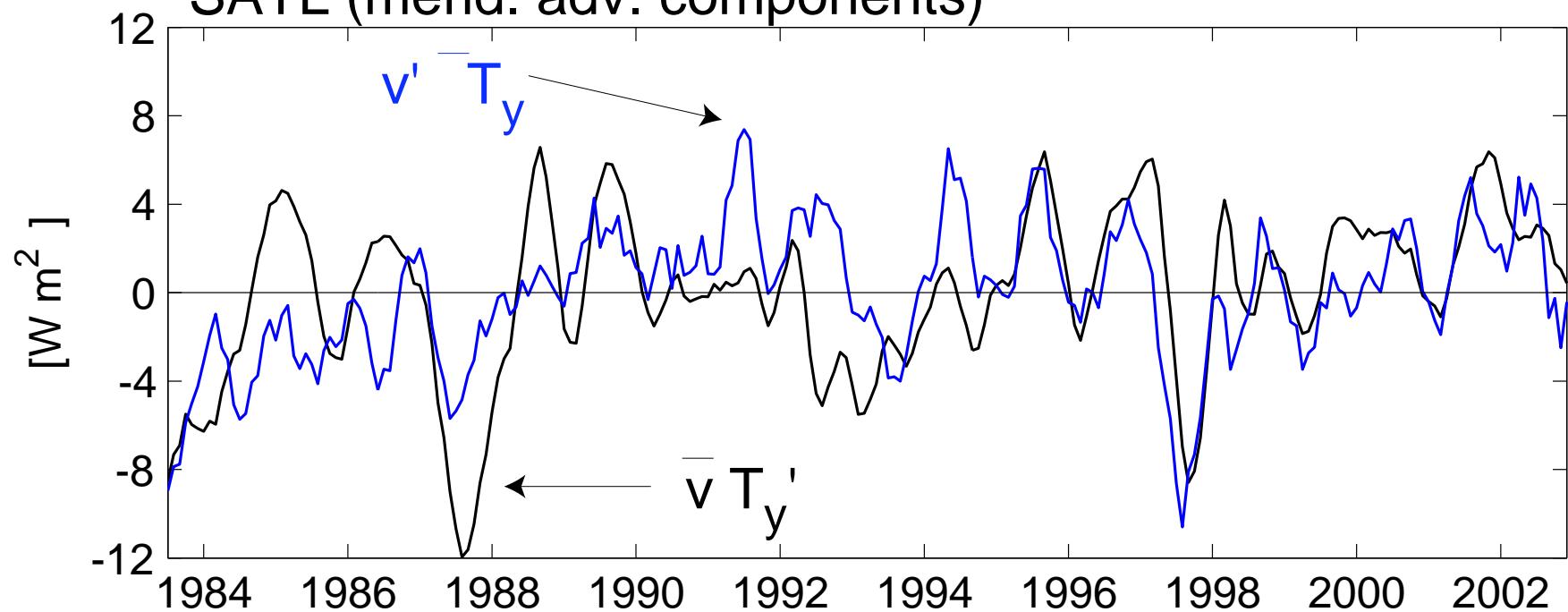


Residual

Balanced heat budget?

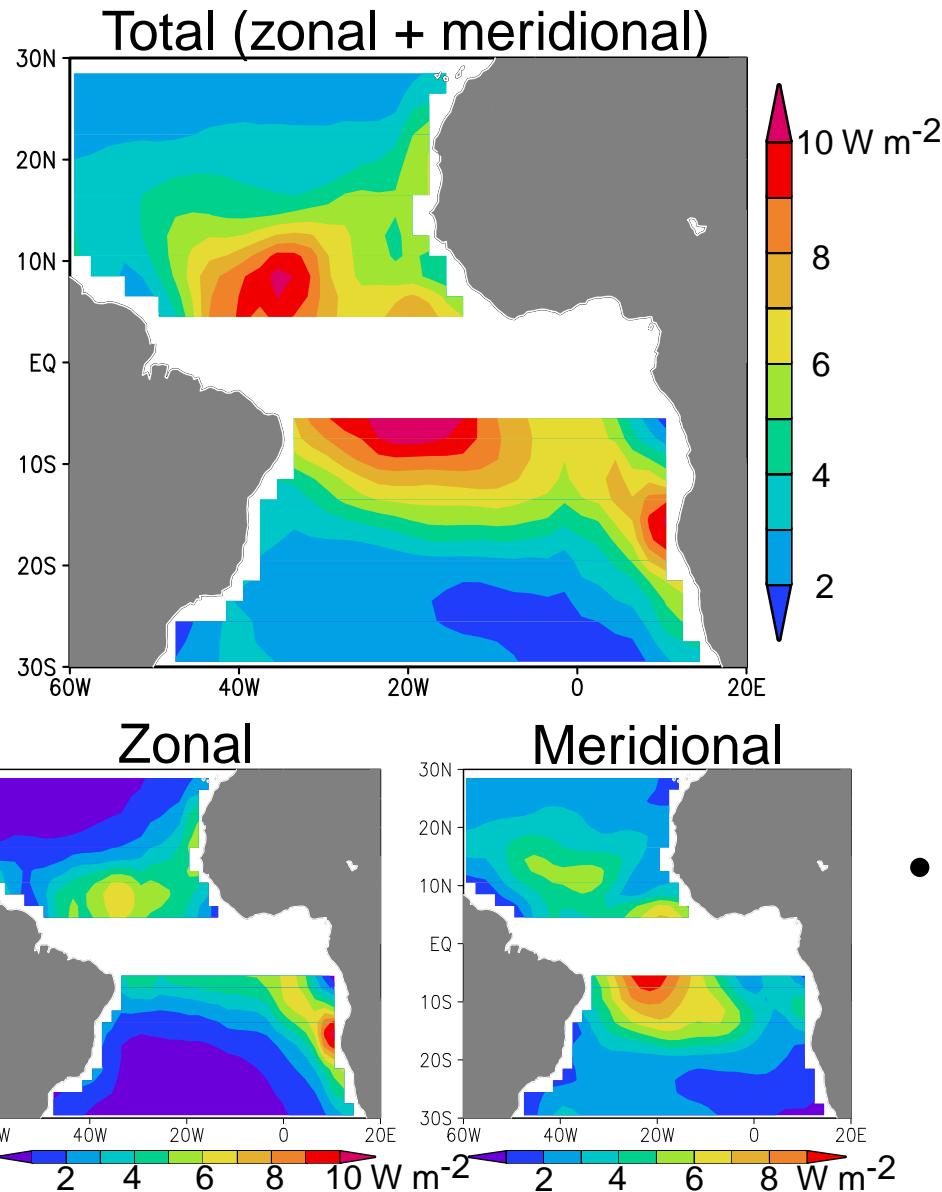


SATL (merid. adv. components)



Ekman advection anomalies

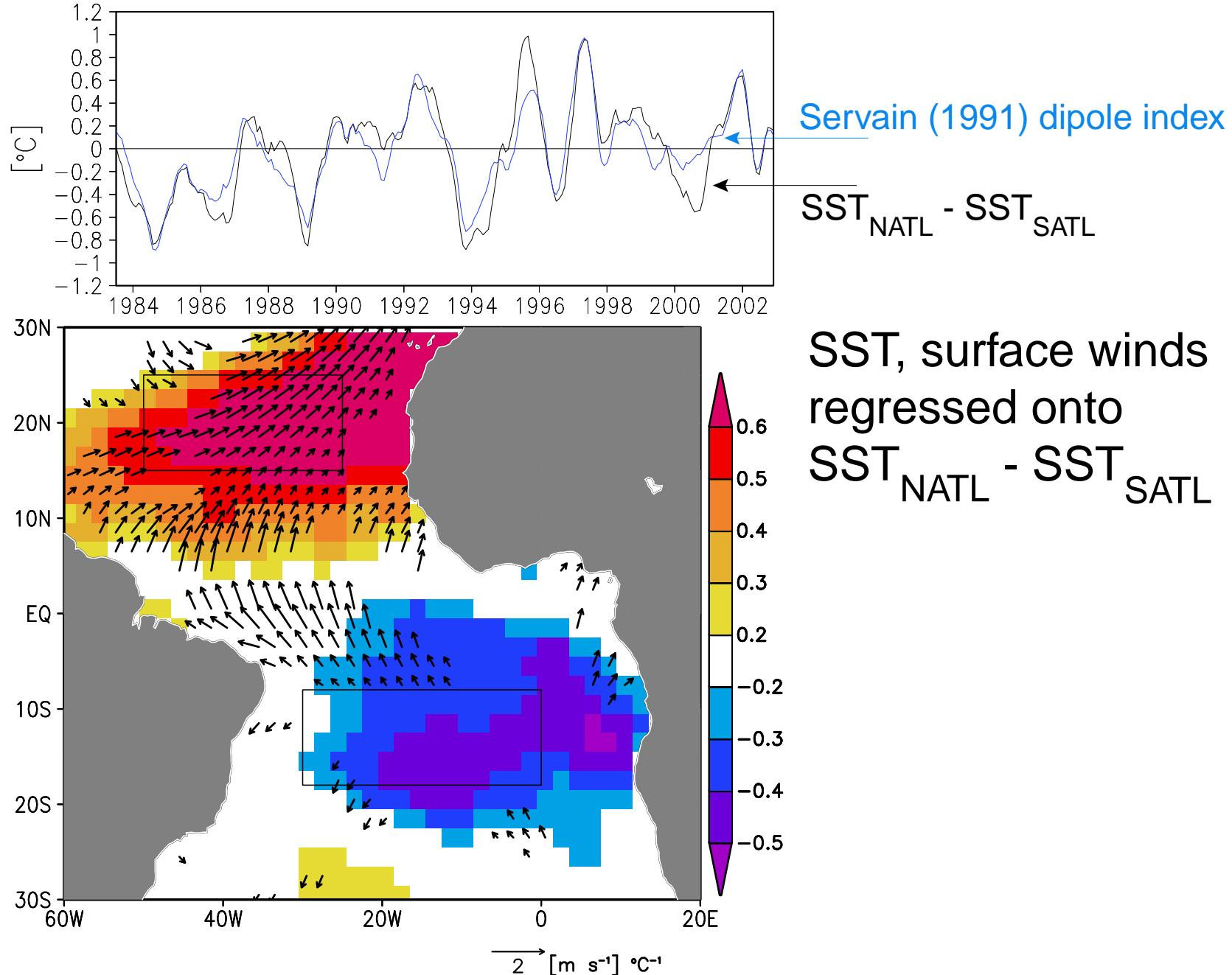
Standard deviation, 1983 - 2002



- Equatorward increase due to mean wind stress, $1/f$ dependence

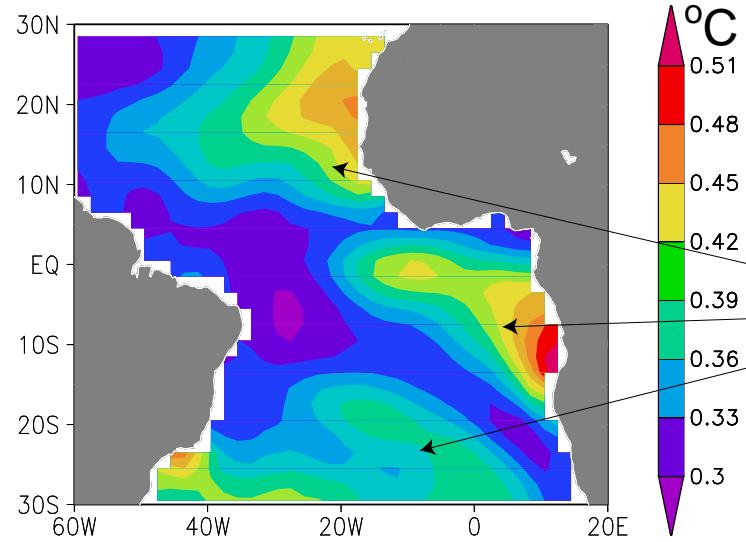
- Meridional dominates in south

Relevance to gradient mode



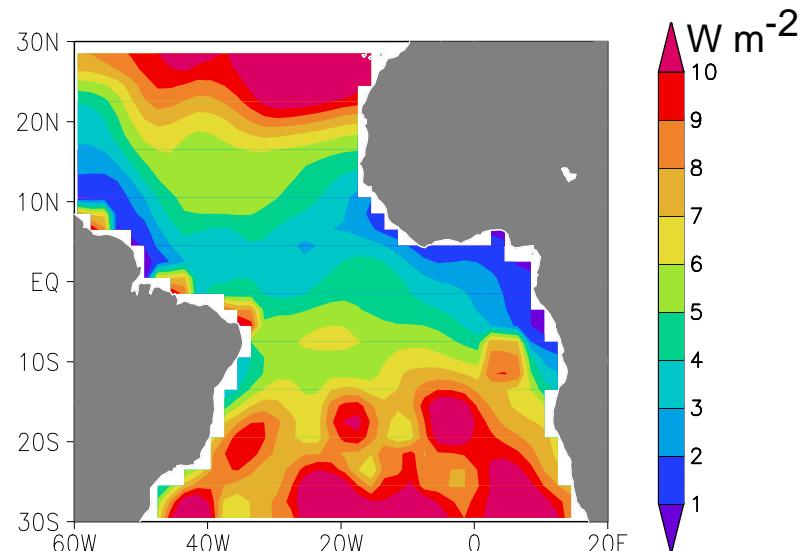
SST, heat storage anomalies

Standard deviation, 1983 - 2002



Sea surface temperature

3 regions of enhanced
variability



Mixed layer heat storage

- Increases poleward due to increasing mixed layer depth